CASE STUDY: PEANUT MINE RECLAMATION PROJECT; GUNNISON COUNTY, COLORADO[1]

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Abstract. The Peanut Mine is located near the Town of Crested Butte in the central Colorado Rockies. The Peanut is an historic coal mine that was active in the late 1800's and early 1900's. Thousands of yards of anthracite coal waste materials, some of which displayed a propensity to spontaneously combust, were left at the site following abandonment.

Following abandonment of the coal mine, a silver mill was constructed at the site. The silver mill, which processed ore transported to the site from throughout Gunnison County, operated sporadically through the mid 1970's. Acid generating silver mill tailings were stored in impoundments situated within and immediately adjacent to the Peanut Mine site.

The Colorado Division of Reclamation, Mining and Safety and Peanut Mine Inc, a non-profit corporation dedicated to preserving open space for public use, formed a partnership dedicated to reclaiming this mixed waste site. This unique partnership not only overcame significant environmental issues, but was able to design and construct the project using innovative reclamation techniques, while providing for federal, state and local involvement in all stages of project design and construction.

Additional Key Words: Spontaneous Combustion, Silver Mill Waste, Partnership

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Introduction

The Peanut Mine Reclamation Project represents a number of unique circumstances that melded together to create an interesting restoration problem. The complexity of the problem required innovative partnerships and technical reclamation techniques in order to accomplish environmental restoration of this property.

The Peanut Mine is located approximately one mile north of Crested Butte in Gunnison County, Colorado (Figure 1). The site is located at approximately 9,000 feet above sea level, and annually receives about 56 inches of moisture, primarily as snow and intense summer thunder showers. The vegetative communities adjacent to the Peanut Mine are predominated by a mountain big sagebrush shrub grassland community.

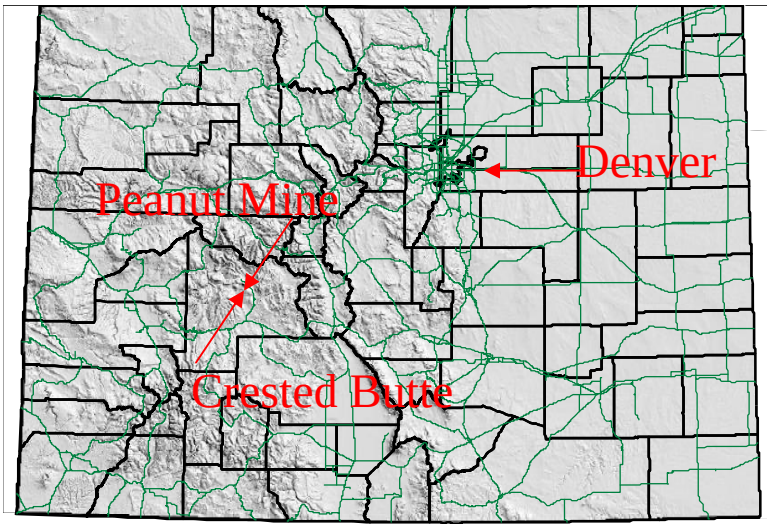

Figure 1. Locations of Crested Butte and the Peanut Mine, Gunnison County Colorado.

This paper discusses the reclamation of the sixteen-acre Peanut Mine, an atypical reclamation project. In order to put the reclamation task into an appropriate context, a history of the site is provided, and a discussion of the partnerships formed between the Colorado Division of Reclamation, Mining and Safety, formerly the Division of Minerals and Geology, and local public interest groups, the town school and state and federal agencies is included, and reclamation techniques used in the process are discussed.

Peanut Mine Site History

The Peanut was a locally moderately significant coal mine, active in the late 1800's and early 1900's. A hard anthracitic coal was extracted from two, four feet thick seams that were mined at the Peanut. Large quantities of refuse were left at the site as a result of the relatively inefficient coal mining and preparation techniques employed at the time. The refuse piles contained large quantities of slightly metamorphosed shales and sandstones intermixed with remnant anthracite. Production at the Peanut ceased as mining operations in the Crested Butte area began to focus on more easily extractable seams of bituminous coal located closer to town.

The higher elevation mountains of northern Gunnison County supported a myriad of relatively small hard rock mines in the late 1800's and into the 1900's. These mines extracted silver, tin, lead, gold, and other semi-precious metals. A Crested Butte area mill site was needed to process silver ore extracted from nearby mining districts. The Peanut mine site was selected for a custom milling operation that accepted ore from throughout the area. It is presumed that this site was selected as it was located close to a railroad, power was available, and water could be obtained from the draining Peanut adit.

The milling facility was constructed on the west side of the Peanut Mine site. Ore was brought to the site, stockpiled and processed at the west side mill. Mill waste materials were deposited at the east side of the Peanut Mine. This mill waste was accumulated in both constructed tailings ponds and in naturally occurring depressions.

Milling operations reportedly occurred on a sporadic basis through the early 1970's. Milling operations had completely ceased by the mid 1970's, and the property fell into disrepair, primarily being used as a convenient, albeit illicit, junkyard and paint ball facility through the late 1990's.

During the 1990's a trail system was being established through the upper Gunnison valley for use by hikers and mountain bike riders. A significant portion of the trail system includes the Lower Loop Trail, which begins at Crested Butte, and traverses through the Peanut Mine property as it extends further north (Figure 2). As a result, a large number walking or bicycling visitors pass through the Peanut Mine property on a daily basis. Historically, these visitors had been exposed to the acid production that is characteristic of the silver mill waste disposal areas east of and adjacent to the Lower Loop Trail.

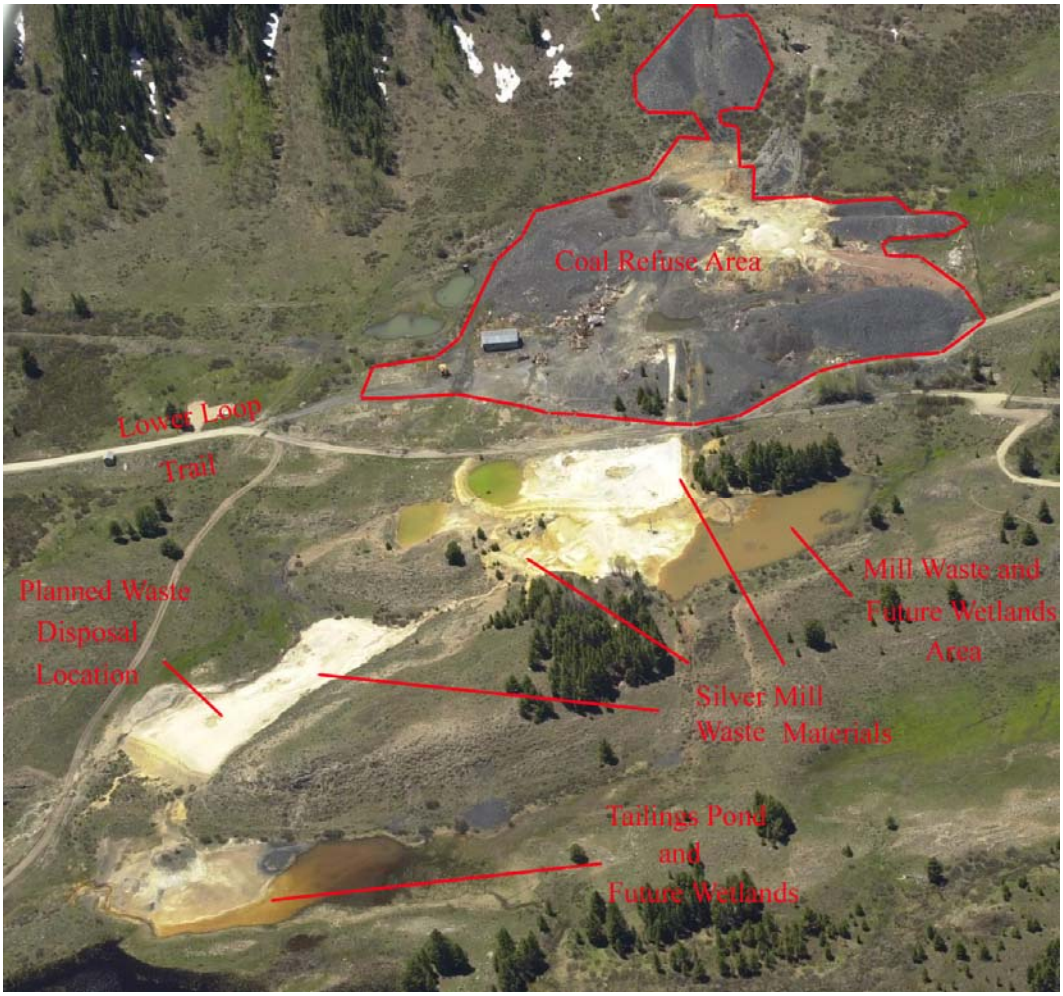

Figure 2. Aerial View of 16-Acre Peanut Mine Site, With Locations of Coal Refuse Materials and Silver Mill Wastes.

The property languished as an eyesore and an environmental problem along the Lower Loop Trail due to the acid production and metals mobilization that occurred as a result of the weathering of the silver mill wastes. The coal waste material on the west side of the Lower Loop Trail compounded site problems. During the summer of 2000, one of the coal refuse piles spontaneously combusted, reportedly not for the first time. The land owner, an energy company based in Wyoming, was notified of the occurrence, and responded to the site. The Colorado Division of Minerals and Geology (Minerals and Geology) consulted to the Crested Butte Fire Protection District, providing guidance on how best to advise the energy company to extinguish the burning refuse pile.

The fire was eventually excavated and extinguished by the land owner. The propensity of the Peanut coal mine refuse to spontaneously combust elevated the mine to a Priority 1 site by Minerals and Geology, as the potential for another combustion event to occur was thought to be high.

Following the fire, the Crested Butte Land Trust, a local non-profit organization dedicated to preserving open space in the Crested Butte area for public use, began to negotiate with the land owner for the purpose of purchasing the Peanut Mine property. Simultaneously, Minerals and Geology began to develop plans geared toward ameliorating the spontaneous combustion potential of the coal refuse. Shortly after it acquired the property, the Crested Butte Land Trust and the Division of Minerals and Geology agreed that reclamation of the entire site was an appropriate course of action to pursue in order to relieve the coal ignition issues and to eliminate the acid production and metals mobilization problems that develop at the site. To that end, Minerals and Geology and the Crested Butte Land Trust began a five-year process to characterize the site, develop community partnerships, establish funding mechanisms, design a reclamation plan, and complete reclamation construction.

State and Local Cooperation

Within a year of the coal refuse fire the Crested Butte Land Trust (Land Trust) acquired the property. Minerals and Geology had previously communicated to the Crested Butte Land Trust its desire to ameliorate the coal combustion issues at the site. Both parties were well aware that reclamation of the entire area was more desirable than reclamation of only the coal related issues. However reclamation of the mixed waste Peanut Mine site exceeded the mission of Minerals and Geology, as only the coal mine portion of the site was eligible for reclamation funding under the Colorado Inactive Mines Program. The easterly portion of the property, which was not eligible for reclamation funding through Minerals and Geology, was heavily impacted by the deposition of silver mill tailings and needed to be an integral part of the overall site reclamation plan. Therefore innovative processes needed to be developed in order that the entire site benefit from the reclamation process.

Discussions between Minerals and Geology and the Land Trust evolved until a plan addressing reclamation of all mine wastes as complimentary components of a larger site restoration project were agreed upon. Minerals and Geology agreed to design, and manage site reclamation, while the Land Trust agreed to finance reclamation of the non-coal portions of the reclamation plan using a variety of non-traditional sources. Minerals and Geology assumed the cost of reclaiming all coal mining related disturbances.

The Crested Butte Land Trust holds many properties for public open space in Gunnison County Colorado. Typically, the properties that the Land Trust purchases are ranches, grazing lands and other agricultural or undisturbed areas. Adding an abandoned mixed waste mine site to its inventory of properties was a novel concept for the organization.

In order to protect its many land holdings from liabilities it could incur at the Peanut Mine, the Land Trust created a subsidiary corporation, Peanut Mine

Inc (PMI), to act as sole owner of the Peanut Mine property. In order to further insulate other properties held by the Land Trust from potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liabilities at the Peanut, PMI applied for and received a Voluntary Clean Up Permit (VCUP) issued by the Colorado Department of Public Health and the Environment (CDPHE). This permit protects PMI from CERCLA liabilities, and allowed the organization to apply for both State and Federal grants to help fund their portion of the Peanut Mine reclamation.

Peanut Mine Inc. applied for grants from the Environmental Protection Agency and the Colorado Department of Public Health and the Environment in order to finance a portion of its reclamation obligation. An EPA Brownfields grant in the amount of $200,000, and a CDPHE grant in the amount of $70,000 were awarded to PMI. These funds, in addition to a $50,000 grant from the Gates Foundation, were used to offset the PMI silver mill waste reclamation financial obligations.

Minerals and Geology and PMI agreed that for economic and construction management purposes, hiring a single contractor to accomplish reclamation of the Peanut would be most efficient. However, both parties had to carefully account for the expenditure of their respective funds during the reclamation construction process. To that end, it was necessary to create a mechanism through which a contractor could be paid for accomplishing specific reclamation tasks, and yet account for the source of the funds used to pay for completion of individual components of specific reclamation tasks.

PMI and Minerals and Geology crafted a Cooperative Agreement and associated cost-by-task based spreadsheet that provided for distribution of funds from the various grants and sources to the contractor as certain reclamation tasks or portions of tasks were completed. Pay centers were established and a project expense / cost center spreadsheet was developed so that billing of individual line items could be accurately and efficiently assigned to the corresponding responsible entity. To accommodate this arrangement, Minerals and Geology established a reclamation account into which all of the reclamation funds from both parties were deposited.

Site Evaluation and Community Partnerships

The first steps in planning reclamation of the Peanut Mine site was to gain an understanding of the environmental impacts of the mixed coal and hard rock waste materials, the characteristics of these materials, and to map existing site conditions and determine the volume of the various waste materials by type.

Rather than completing reclamation planning in a vacuum, Minerals and Geology made a commitment to PMI that it would involve the community in the entire reclamation process. To this end, Minerals and Geology funded a

Reclamation Studies class at the Crested Butte Community School. This class emphasized characterization of highly disturbed areas, and planning for rehabilitation of such a site. The class used the Peanut Mine as an outdoor classroom, obtaining samples of the various mine wastes for geochemical analysis, performing water quality sampling, and establishing vegetation test plots to help design site-specific soil and revegetation suggestions, among other reclamation related activities.

Minerals and Geology also enlisted the help of the community when developing the seed mixture to be used to revegetate the site. Minerals and Geology ecologists developed a conceptual seed mix for the site. Area residents knowledgeable about local vegetative communities were asked to review the seed mixture and offer suggestions regarding alternative species, seeding rates and other pertinent aspects of the plan. As a result of this collaborative effort, the mixture was refined so that local conditions were best accommodated. Further, local volunteers gathered seed from a number of area specific species to supplement the commercial seed mixture.

In addition to this work, Minerals and Geology recruited the Office of Surface Mining, Western Coordinating Center (OSM), to construct a pre-reclamation topographic map of the site using LIDAR technology. The OSM flew the site and provided the LIDAR generated data to Minerals and Geology. This information, field verified by Minerals and Geology, was used as the basis for topographic maps that were manipulated to design post-reclamation topography and for ascertaining material cut and fill volumes.

Minerals and Geology also conducted geochemical evaluations, geotechnical investigations, water quality analysis and other pertinent investigations to fully characterize the site. This information provided the basis for development of a reclamation plan that addressed the entirety of the site so that a holistic approach to site remediation could be developed.

In order to accommodate various regulatory requirements, two reclamation construction related permits were necessary before construction could begin. Peanut Mine Inc, as owner of the property, was the applicant for each permit. Because Minerals and Geology was designing and supervising reclamation construction, it acted as the on-site permit coordinator.

The U. S. Army Corps of Engineers was consulted early in the reclamation planning process, in order to ascertain whether any Clean Water Act issues would be presented during site reclamation. Because the watercourse that conveys the adit drainage would be reconstructed during reclamation, a Section 404 permit was issued. The permit was later modified to accommodate dredging and filling of a wetlands area contaminated by mill waste products.

The Colorado Department of Public Health and the Environment was contacted to determine the necessity of obtaining a stormwater discharge permit to accommodate construction and post reclamation sedimentation issues. At the advice of CDPHE, a stormwater management plan was developed and a stormwater discharge permit was issued to PMI. The stormwater management plan was developed in such a manner so that reclamation requirements imposed on the contractor as part of the construction specifications dovetailed with the requirements of the plan. Therefore, if construction proceeded as required in the reclamation contract, the site would remain in compliance with the permit.

Reclamation Plan

The reclamation product that Minerals and Geology and PMI envisioned for the Peanut Mine was to create a geomorphically stable landform that included isolation of silver mill wastes and reduction of coal spontaneous combustion potential, while accommodating eventual use of the area as public open space for non-motorized recreation. A multifaceted approach to reclamation of the site was adopted in order to meet the post reclamation site goals:

- Consolidate all waste materials into a disposal facility for the purpose of isolating the silver mill wastes from the environment and to reduce its acid generation potential;
- Dilute and compact the coal wastes in the disposal facility in order to reduce its spontaneous combustion potential;
- Create geomorphically stable landforms at the disposal area and at the former locations of the waste materials;
- Accommodate overland flow of snowmelt and rain waters through creative placement of channels;
- Encourage development of on-site wetlands areas;
- Encourage wetlands development at specific portions of the site;
- Create a plant growth medium capable of sustaining vegetative growth;
- Establish species capable of replicating the characteristics of adjacent vegetative communities.

In order to comprehensively address the environmental issues at the site, a reclamation plan was developed that accommodated the geochemistry of the various materials and the topography of the site.

Geochemical testing of the waste materials when mixed indicated that the coal refuse had a propensity to buffer the acid generation potential of the silver mill wastes. Analysis of the testing results indicated that mixing the materials at a ratio of two parts silver mill waste to one part coal refuse would buffer the silver mill waste. Analysis of the material volume balances indicated that using this mixture ratio would allow for a minimum five feet thick compacted coal refuse cover to be applied over the mixed waste materials. This compacted coal refuse

cover would act as a cap to minimize water infiltration to the mixed wastes while providing a rooting medium for vegetation.

Geotechnical testing of the mixed materials demonstrated that combining the wastes at the specified ratio, and compacting them on a one foot vertical interval would provide sufficient structural strength for a free standing disposal area approaching thirty five feet in height at a 2H:1V or steeper outslope angle.

Evaluation of various physical and topographic characteristics of the site revealed that a canyon used as a mill waste disposal area would provide adequate capacity for the disposal of the mixed waste materials. This location allowed the fill to be buttressed on two sides by the canyon walls, minimized the potential for overland flow to encroach on the disposal area, and provided an opportunity to design a geomorphically functional fill surface.

Because the site was severely disturbed by past mining and milling operations, virtually no topsoil or topsoil substitute was available for reclamation purposes. Initial reclamation concepts envisioned adding organic material to remnant coal refuse and revegetating that material. However, local housing and commercial construction activity accelerated between 2002 and 2004. A relatively large quantity of fill dirt was generated due to excavation of building sites in the upper Gunnison valley. The Peanut Mine site was offered as a place to dispose of this relatively clean fill dirt, and eventually approximately 15,000 cubic yards of fill was stockpiled at the site. Additionally, the Town of Crested Butte provided approximately 500 cubic yards of EPA approved bio-solids to the site.

The final reclamation plan evolved as analysis of the various physical site parameters were evaluated. The plan contemplated removal of silver mill tailings from the canyon located at the southern portion of the Peanut, shaping and compacting the exposed base of the canyon, and installing a coarse rock underdrain system. A six-inch lift of crushed limestone encased in permeable geotextile was to be placed in the canyon bottom, so that it was interwoven with the coarse underdrain. Mill tailings and coal refuse were to be placed at the specified mixture and compacted to 90% dry density at 15% optimal moisture content. A five to six feet thick cover of coal refuse, compacted to the same specifications, was to be placed over the top of the mixed materials.

Coal refuse on the west side of the Lower Loop was to be excavated until natural ground level was encountered, while two feet of the native ground surface below the east side silver mill tailings was also excavated.

The imported fill was to be evenly distributed at a nominal twelve-inch depth across the entire site. Once on the ground, certified weed free straw mulch, dry cow manure and the bio-solids were to be distributed across the ground surface. This material was to be worked into the ground surface until all organics were thoroughly incorporated.

Shrub islands were to be created as part of the revegetation plan. The shrub islands consisted of exclusively seeding shrub species in small but distinct area across the site. Grass and forb seed was to be hand distributed outside the shrub islands followed by additional mulch application and hand crimping.

Approximately 4,500 seedling trees were to be planted in clusters around the site following completion of all other reclamation operations. An all-volunteer tree planting effort was planned in order to help generate long-term local support and interest in the reclamation project.

Channels to accommodate mine adit drainage and flows resulting from snow melt and rain events were to be constructed. Steeper channels were to be constructed using various velocity reduction devices, while shallower gradient channels were planted with quick growing sterile and native grasses. Willows, both containerized and from locally obtained cuttings, were planned for placement along channel margins and at portions of the property anticipated to hold sufficient moisture to support their growth.

Once completed in draft form, public meetings were held in Crested Butte so that the public had an opportunity to review the plan and make comments or recommendations and to ask questions. The meetings also served as a vehicle to educate the public as to what they could expect to occur at the site during construction, and for the years following completion of the project.

Construction

Reclamation construction was planned to begin during the summer of 2003. A slower than usual contracting process, and a long delay in processing the EPA Brownfields grant resulted in construction being substantially delayed until 2004.

During site characterization work, three previously unknown underground petroleum storage tanks were discovered. Exploratory excavation around the periphery of the tanks suggested that some amount of leakage had occurred. The Colorado Geologic Survey (CGS), the State authority in mitigation of underground storage tank contamination, was contacted by Minerals and Geology to assess the site and develop a remediation plan. Under CGS supervision, the underground storage tanks, along with associated stained soils were excavated and removed from the site in the late summer of 2003.

During the winter of 2003 / 2004, Minerals and Geology, PMI and the reclamation contractor agreed to begin construction in early July 2004. In mid-June 2004 the contractor notified Minerals and Geology that it was financially unable to conduct the work, was on the verge of filing for bankruptcy protection and would not begin the project. The second lowest bidder was contacted in an

effort to salvage the summer construction season, but that contractor declined to honor the prices bid the previous year. As a result, certain portions of the plan were changed to accommodate rapidly rising fuel costs, and the project was again put out to bid in the fall of 2004 in anticipation of 2005 construction.

Equipment arrived on the site in mid-July, 2005. Site preparation included construction of a safety fence on both sides of the Lower Loop Trail for the length of the Project Area, placement of silt fence below the waste disposal area, application of magnesium chloride on the dirt road between Crested Butte and the Project Area for dust control purposes, stripping of soil and vegetation from the canyon side slopes at the disposal area, and removal of tailings from the footprint of the planned disposal area.

A french drain was constructed along the westerly margin of the disposal area so that it intercepted near surface ground water and allowed that captured water to drain to a surface channel built at the southern margin of the area. The drain was constructed so that it gradually decreased in depth as the ground surface elevation fell, resulting in the base of the drain being relatively horizontal. Therefore, at its outlet, the elevation of the base of the drain coincided with the ground surface elevation, allowing for a free draining system.

When removal of the tailings from the footprint of the disposal area was completed, shaping and compaction of the base was accomplished. The area beneath the tails had supported a drainage channel prior to tailings deposition. This former drainage channel now formed a groin-like inflection sloping from north to south through the area. The old drainage footprint was used to create the primary segment of an underdrain system. Five lateral interceptor drains were built to extend westerly from the primary drain to capture drainage from the periphery of the disposal area, and deliver this drainage to the central drain.

The drainage system trenches were excavated into the graded and compacted base of the disposal area to one foot below ground surface. Geotextile was placed within the cuts, and coarse durable rock was placed so that the excavation was filled to about one foot above ground surface elevation. The geotextile was wrapped over the top of the durable rock, so that the rock was completely enclosed by the geotextile.

Following underdrain construction, the base of the disposal area was ready for placement of the limestone base material. Geotextile fabric was placed over the base of the compacted disposal area, and crushed limestone was spread to a six-inch thickness. Placement of an overlying geotextile occurred as the limestone placement was completed.

Coal and silver waste materials were then transported to the disposal area as the limestone placement was completed. Coal Refuse and the silver mill waste materials were trucked to the disposal area and were mechanically mixed on the

pad using a dozer. The mixed material was then pushed out over the pad in one-foot thick lifts.

Compaction and moisture testing of the mixed waste material occurred on a predetermined schedule. Twenty tests were conducted per foot of elevation gain over the first five lifts. Ten tests per lift were completed at about five feet elevation intervals between lifts 5 and 22.

In some areas, excavation of the silver mill waste resulted in creation of large, enclosed depressions, varying from six to eight feet in depth. Coal refuse was placed and compacted into these depressions to create a desirable post reclamation landform and drainage pattern in these areas.

The silver mill waste material became increasingly saturated as excavation of the material deepened. Saturation became so severe that the material oozed water immediately when cut with a track excavator. While this was not an unexpected condition, it caused some disposal area stability concerns, due to the plasticity of the material, its apparent lack of strength and the elevated moisture content. In order to accommodate this situation, coal refuse was added in sufficient volumes to the wet mill waste in order to stiffen the mixture so that it would not cause structural problems within the fill. Approximately three to four parts of coal were added to every part of saturated mill waste to create a material sufficiently dry to compact appropriately. Additionally, this material was preferentially placed so that it was located no closer than approximately 80 feet from the face of the disposal area.

Periodically, the contractor was directed to selectively take certain coal materials to use in the mixing process. It was preferred that specific materials, such as coal clinker, be buried deeper within the disposal area, as they are a poor growth medium, while other coal refuse material appeared to be better suited to support vegetation, and thus were more desirable for placement in the upper reaches of the disposal area.

Following completion of the 15-foot lift, all of the silver mill wastes had been mixed and placed in the disposal area. Minerals and Geology then re-surveyed the disposal area and the remaining coal refuse materials to be placed in the fill. The survey revealed that the disposal area contained excess volume; that is, the volume of remaining coal refuse materials was insufficient to meet the design elevations of the disposal area.

One important consideration in the disposal area design parameters was to construct the back slopes of the disposal area to an elevation equivalent to that of the adjacent canyon margins. This was an important consideration in order that the volume of run-on water from off-site areas was minimized, and so that a functional landform in the context of the adjacent areas was created during the reclamation process. In order to accomplish this, given the apparent material

shortage, the outslope angle of the disposal area was relaxed from 3H:1V to 6H:1V. Changing the outslope angle allowed the fill to rise more rapidly so that when completed, the back of the fill would match the elevation of the canyon rim.

In order to keep the public informed of reclamation progress, weekly reclamation tours were conducted. Either Minerals and Geology or PMI conducted a site tour each Tuesday evening during construction. Weekly progress reports were made and questions regarding the reclamation process or work progress were answered. This simple but effective tool went a long way toward promoting project benefits, and in educating the public regarding environmental restoration concepts.

Excavation and disposal of all coal refuse and silver mill wastes was completed by mid-October, 2005. Approximately 87,000 cubic yards of mine waste material had been excavated and placed in the disposal area by that time.

Approximately 15,000 cubic yards of clean fill that had been imported to the site was evenly distributed over final cut and fill land surfaces of the Project Area. This volume of material allowed an average placement of one foot of dirt over most of the Project Area. Because most of the imported fill was essentially devoid of organic materials, and lacked any soil-like characteristics, organic materials were incorporated into the material after it was distributed across the site.

Project specifications required that two tons of certified weed free straw per acre be distributed over the 16-acre Project Area, in addition to three tons of dry cow manure per acre and 1,200 pounds per acre BioSol Plus (7-3-3), and the approximately 500 cubic yards of bio-solids that had been stockpiled on the site.

The straw mulch was hand distributed over the site, while the manure, BioSol and bio-solids were mixed using the track excavator, placed in a manure spreader, and distributed. A small dozer was used to rip the organic materials into the imported fill surface at the flatter portions of the area. Ripping occurred parallel to contour, in order to incorporate the organic material, and to disrupt surface water drainage in order to slow overland flow velocities and reduce erosion potential.

The organic materials were incorporated into the imported fill distributed over slopes that were 6H:1V or steeper by a track excavator. To do this, the operator pushed the teeth of the bucket into the dirt to a depth of about eight to twelve inches, and then curled the bucket toward the machine to create an upslope depression and downslope mound in the dirt surface, thus incorporating the organic material. This process occurred so that an eighteen to twenty four- inch separation between gouges parallel to contour was created. The gouges were constructed in an offset pattern, so that a gouge was constructed immediately

above and below any open space between two horizontal gouges. This created a very disrupted landscape, which severely inhibits overland water flow patterns.

Concurrently with surface roughening, channels were built to convey water across the site. A site drainage concept to support a diversity of land uses and eco-types was devised. The drainage plan for allowed water to move through the site to a wetlands area constructed as part of the project at a former tailings disposal area near the southern portion of the site. Drainage patterns were also created so that some water could accumulate in areas that supported willow and other wetlands vegetation near the northwest corner of the property.

Following surface roughening and incorporation of organic material, shrub island areas were established. In order to create the shrub islands, approximately ten shrub areas per acre were designated. Only shrub seed was planted in these approximately thirty feet diameter areas.

Following shrub seed distribution, grass and forb seed was planted outside of the shrub islands. When all of the seed had been distributed, two tons per acre of certified weed free straw mulch was applied to the ground surface. Hand crimping was required in the contract, but rather than using hand-crimping tools the contractor fitted ski boots with sharpened metal plates constructed to drive the mulch into the ground. The crew walked the area with the crimping boots, which served to firmly secure the mulch to the ripped ground surface.

Approximately 1,200 willows were planted at the site. Five hundred of the willows were containerized, while the remainder of the willows were obtained from cuttings collected on site. Willows were preferentially planted along the constructed channels, and at appropriately moist areas created near the northwest corner of the site.

The contractor was required to provide 5,600 seedling trees to the site. Approximately 1,866 trees each of Quaking aspen (Populus tremuloides), Blue Spruce (Picea pungens) and Engelmann Spruce (Picea engelmannii) were delivered to the site in mid-October, 2005.

Minerals and Geology, in conjunction with Peanut Mine Inc and the Crested Butte Land Trust, hosted a public tree-planting day at the site following completion of all other revegetation activities. Trees were planted in designated areas that were located so that they complimented the shrub islands and took advantage of site micro-topography. Seventy-five volunteers helped plant approximately 4,500 trees on October 22, 2005.

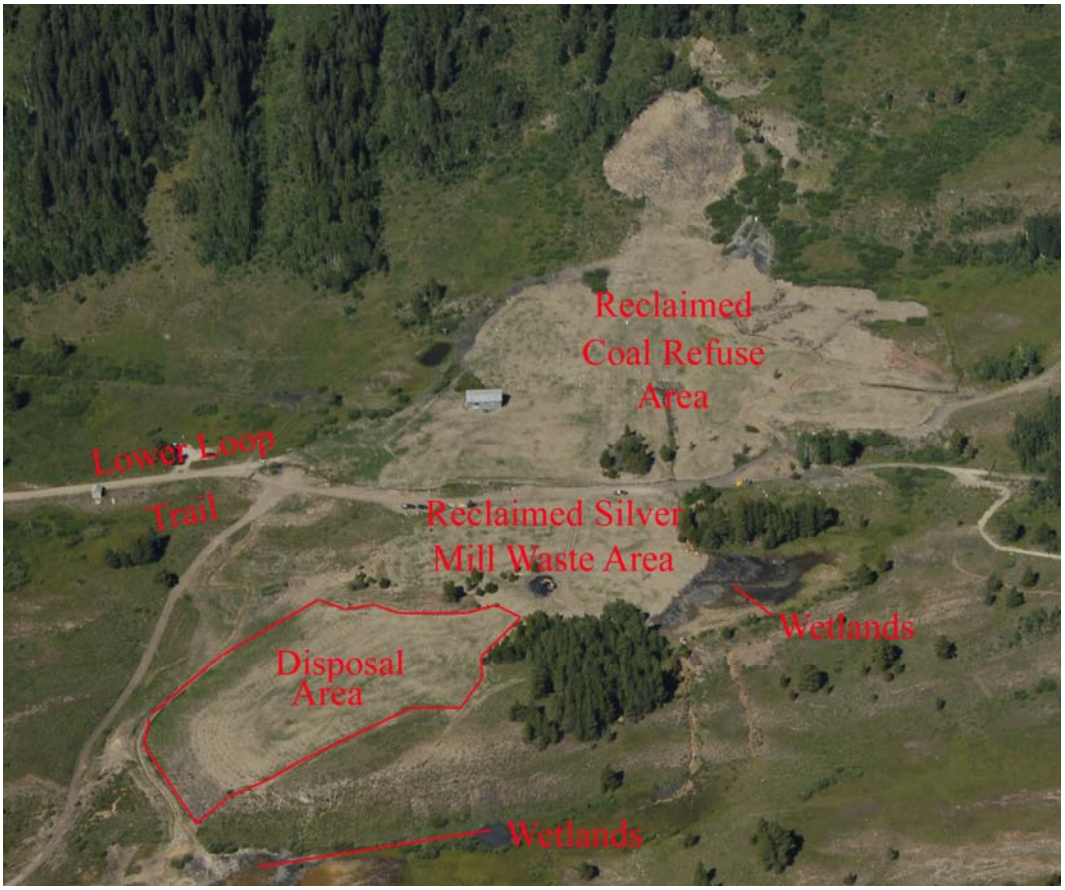

Figure 3. Aerial View of Peanut Mine, Eight Months Following Completion of Reclamation Construction.

Conclusions

The Peanut Mine reclamation project provides many examples of how a dedicated collaborative process can lead to highly successful results.

In the case of the Peanut project, Minerals and Geology had committed to a reclamation planning and implementation process that provided for the involvement of not only the landowner, but also the entire community. Minerals and Geology felt that community involvement in the entire process was extremely important in order to ensure a successful reclamation outcome at the Peanut due to the proximity of the site to town, because the Lower Loop trail, which bisects the Project Area, is an important and highly used hiking and biking path, and because community interest in the local environment is strong. The agency desired to facilitate a community based solution to the environmental issues presented by the Peanut, rather than compel a solution.

By acting as a clearinghouse for problem analysis and resolution, Minerals and Geology helped create a dialogue between the community, the landowner, and various state and federal agencies. This communication enabled a trusting

relationship that, in the long term, allowed for great latitude in reclamation creativity.

Achievement of this goal was possible because the agency was willing to invest time and resources in the community. Funding the school to initiate the Reclamation Studies class, holding public meetings and site tours, assisting the Fire Department when the coal spontaneously combusted, enlisting public involvement at various stages of the reclamation planning process, hosting the volunteer tree planting and providing a willingness to discuss the various aspects of the project were extremely valuable activities that allowed the community to fully participate in the various aspects of accomplishing this project just outside of the town.

By fostering an atmosphere of collaborative planning and implementation, numerous hurdles were overcome and many issues resolved, all of which served to improve the final reclamation product at the site.

The technical difficulties presented by the mixed waste site were solved using sound scientific principles and careful planning. The materials that, at first blush, appeared to present great technical difficulties, were eventually found to work in tandem to mitigate site issues. The landforms created at the cut and disposal areas appear to be extremely stable in terms of functionality and by supporting a variety of micro ecosystems for long-term vegetative success.

The Peanut Mine received over sixty inches of snow during the winter of 2005 / 2006. Virtually no erosion occurred at the site as a result of snowmelt in the spring of 2006. Long term vegetation monitoring transects were established in the summer of 2006. Initial sampling suggests that many shrubs and grasses are beginning to become established. Cover and diversity sampling will continue for a three to five year period in order to help quantify reclamation success.